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1. Copy of applicable Ventilation Code.
2. Copy of Ventilation requirement from Lease.
3. HVAC load Calculations for Typical floors based on actual exiting conditions. Includes:

Building 2

Building 3 AHU A & B

Building 4 AHU A & B

4. Comfort Control Air Balance Report Data.

1. PURPOSE

Girard Engineering and Comfort Control were asked to study the outside air ventilation system for the Metro Center Complex buildings 2, 3 and 4. This work was completed during the period beginning April 19, 2000 and completed on May 5, 2000. The purpose of this study was to evaluate the building's ventilation and air conditioning systems to determine if they meet lease requirements, meet code and contribute in any way to occupant complaints regarding the ventilation system.

2. EXECUTIVE SUMMARY

The Silver Spring Metro Center Buildings 2, 3, and 4 were analyzed by Girard Engineering and Comfort Control in May, 2000. The result of this study is the following findings and recommendations.

A. Findings:

1. HVAC system outside air ventilation system was originally designed and is now actually operated to meet lease and code requirements.

2. Ventilation air quality does not meet current code or ASHRAE standard 62-89.

3. Sufficient outside air is provided to balance toilet exhaust and maintain a positive pressure in buildings.

4. Building 2 and 3 were actually measured to have a positive pressure.

5. HVAC system is well maintained, is clean and has good air filtration.

6. Operation of pneumatic temperature controls has degraded with age. Some controls are not operating per original design.

B. Recommendations:

1. Up-grade outside air ventilation system to meet current building code and recommendations of ASHRAE standard 62-89. This will significantly increase the amount of outside air provided.

2. Continue current good periodic maintenance and cleaning procedures for Air Handling Equipment.

3. Repair and calibrate existing automatic controls as follows:

a. Repair or replace any defective VAV box controls.

b. Set all AHU discharge static pressure controls at 1.25 to 1.5 in wc to make sure adequate air flow is provided to all zones.

c. Set AHU discharge temperature at 55ºF in cooling seasons to maintain low space humidity levels. AHU discharge temperature may be set higher in winter when outdoor temperature and humidity is low.

d. Lock-out operation of morning warm-up controls during occupied hours to maintain a constant ventilation supply.

e. Make sure all VAV Box valves are set at a minimum of 20% air flow for good air distribution to all building areas.

The above recommendations will improve building ventilation rates and effectiveness to current national standards.

3. SCOPE OF SERVICES

The scope of services for this/study report is as follows:

A. Girard Engineering

1. Review reports/studies prepared by NOAA Consultants for Building 2.
2. Review of existing building HVAC and ventilation systems.
3. Review original building HVAC system design.
4. Review of tenant HVAC system design.
5. Review humidification system.
6. Site visits to survey building systems by mechanical engineers.
7. Interview building operating personnel.
8. Review air balance reports prepared by Comfort Control.
9. Review original GSA lease requirements for design of the HVAC ventilation system.
10. Compare building HVAC design to code requirements in affect when buildings were designed.
11. Prepare a written report of findings and recommendations.

B. Comfort Control

1. Measure actual outside air flow to building floors indicated.
2. Measure typical floor A/C unit supply air temperature and humidity.
3. Measure typical floor A/C unit return air temperature and humidity.
4. Measure typical space temperature and humidity.
5. Review operation of typical variable air volume boxes.
6. Review operation of AHU morning warm up control.

7. Building 2

- Capacity test outside air fan and measure OA quantity on floors 4, 9, 14 and 15.
- Survey 4th floor (approximately 12 VAV boxes)
- Survey 9th floor (survey of all VAV boxes on this floor)
- Survey 14th floor (approximately 12 VAV boxes)
- Survey 15th floor (approximately 12 VAV boxes)

8. Building 3

- Survey 3rd floor (approximately 12 VAV boxes)
- Survey 8th floor (approximately 12 VAV boxes)
- Survey 15th floor (approximately 12 VAV boxes)

9. Building 4

- Survey 3rd floor (approximately 12 VAV boxes)
- Survey 7th floor (approximately 12 VAV boxes)
- Survey 13th floor (approximately 12 VAV boxes)

4. DESCRIPTION OF BUILDINGS TO BE SURVEYED

The buildings and floors to be surveyed are listed below. A sample of floors in each building is surveyed. This sample is considered representative of all floors in the buildings.

Building

Silver Spring Metro Center 2
15th Floor
14th Floor
9th Floor
4th Floor

Silver Spring Metro Center 3
15th Floor
8th Floor
2nd Floor

Silver Spring Metro Center 4
13th Floor
7th Floor
3rd Floor

These buildings are typical Class A office buildings. They are occupied by the NOAA government agency. The space is typically used as administrative office space with normal associated related occupancies.

5. SURVEY RESULTS - BUILDING 2

A. Description of Building 2 HVAC System

Building 2 is an 18-story office building with approximately 280,000 sf area. The A/C system has a chilled water Air Handling Unit (AHU) on each floor. The AHU is a Variable Air Volume (VAV) type with fan inlet vanes for static pressure control. Cold air is supplied through horizontal ducts to VAV terminal boxes. There are approximately 15 parallel fan powered VAV boxes with electric duct heaters which serve the perimeter zones. Zones served vary in size between 300 and 1,200 square feet (SF) area. There are 10 shut off type boxes which serve interior zones. There are a total of 25 VAV boxes per floor. Average zone size is 620 sf. This small zone size normally provides excellent temperature control.

The ventilation system consists of an Outside Air (OA) duct riser with an intake louver in the penthouse wall. There is an OA ventilation supply fan on each floor in the mechanical room. This fan draws air out of the ventilation duct riser and supplies it to mix with return air and be circulated to the floor through the VAV boxes. The outside air fan is typically sized for 1,350 cubic feet per minute (cfm) of air per floor.

B. Observations Building No. 2

As a result of our review, the following was noted for Building 2:

1. Building 2 construction started in April of 1988. Construction was completed in December of 1989.

2. The building was designed per the 1987 BOCA code in effect at that time.

3. The GSA lease required a minimum ventilation rate of 5 cfm per person.

4. The 1987 BOCA mechanical code requires 20 cfm of “Ventilation” air per person. However, ventilation air is defined as total air circulation with “outside” air being 33% of the total. Or 33% of 20 = 6.6 cfm OA per person. The quantity of people is determined by the Building Code based on 100 square feet per person for the gross floor area. In Building 2, the gross floor area is 18,000 sf so, the floor occupancy for calculating outside air requirements is 180 persons. This is 1,188 cfm of OA based on 6.6 cfm per person. The 6.6 cfm of OA exceeds the GSA lease requirement of 5 cfm per person.

5. The actual amount of OA supplied per floor per the original building design is 1,350 cfm. This exceeds the maximum code requirement by 14% and exceeds the GSA lease requirement by 50%.

6. The current applicable building code for office building ventilation is the 1996 International Mechanical Code (IMC). This code is based on ASHRAE standard 62-89. For this building the 96 IMC requires 20 cfm of OA per person. Occupant load is based on 7 persons per 1,000 sf of air conditioned area. Occupant load per 96 IMC is therefore 15,500 sf ÷ 1,000 x 7 = 109 persons. OA requirement of 20 cfm per person is (109 x 20) = 2,180 cfm. The current code requires 60% more outside air than original design.

7. Air Balance Calculation

The following calculates the building exhaust rate compared to the supply air rate. This is to verify sufficient OA is supplied to balance building exhaust and to evaluate building pressurization. Building pressurization is the amount of OA supplied in excess of the exhaust rate. The total OA quantity supplied to the building is 22,575 cfm. This is supplied by 16 OA fans at 1,350 cfm each. The total building exhaust is 15,200 cfm. This is based on the add up air quantity for toilet exhaust and janitors' closet exhaust for the building. Tenant drawings indicated that exhaust fans were provided for smoking rooms on each floor. However, these fans are not currently operated. So that exhaust rate is not included in the calculation. The air balance calculation indicates an over supply of outside air of 7,375 cfm. This air quantity serves to "pressurize" the building. Each floor is supplied 1,350 cfm of OA. The toilet exhaust is 900 cfm. This yields a positive air balance of 450 cfm per floor to pressurize the floor.

C. <u>Conclusion - Building No. 2</u>

The quantity of OA provided for Building No. 2 exceeded the code requirement and lease requirement when the building was originally constructed. The existing OA quantity does not meet the building code now in effect.

D. Review of Existing HVAC System Design – Building No. 2

1. The existing system is of a "standard" design. However, it was considerably over designed in capacity due to lease requirement for additional electric equipment "plug" load added to the A/C calculation. A load of 7.5 watts per sf was required by the lease. The typical floor AHU capacity is 24,000 cfm. Floor air conditioned area is 15,500 sf. This provides 1.55 cfm per sf of air supply. Normal office buildings operate at 1.1 cfm/sf air supply. Because this is a VAV system, the system will operate satisfactorily at this lower air quantity.

2. A humidification system was installed for the building. This was done by adding an individual self-contained electric steam humidifier unit to each typical floor AHU. These humidifiers were operated for a short period. Operation was discontinued in early 1999.

3. A HVAC system "Block Load" calculation was made to check capacity of the typical floor AHU. The block load is based on typical floor actual load condition of 2 watts/SF for lights and 3 watts/SF for "plug load" power. This calculation indicates an AHU supply air quantity of 16,860 cfm is adequate for a typical floor. The actual AHU capacity is 24,000 cfm. This is 40% higher than required.

The individual VAV boxes are also designed for this higher HVAC plug load than exists in the space. So box air quantity is higher than necessary. As noted in the balance report, most of the VAV boxes are operating at a lower than design air quantity. This does not create a problem because room loads are lower than anticipated by the original design.

4. Space Temperatures

All average space temperatures were in a good acceptable range for occupant comfort.

5. Individual VAV Box Air Quantity

Air quantity supply for most VAV boxes was measured to be lower than design CFM indicated on tenant drawings. Measured diffuser air quantity is lower than design in many cases. This occurs when associated VAV box is low in air quantity. The low VAV box air quantity appears to be caused by low duct static pressure or controls out of calibration. The low VAV Box air quantity generally does not affect tenant comfort because the boxes are considerably oversized.

E. Analysis of Air Balance Report – Building No. 2

This is to summarize and discuss the air balance report findings for Building 2.

	Existing OA Supply Fan		**Toilet Exhaust CFM**	
	Design CFM	**Measured CFM**	**Design CFM**	**Measured CFM**
Floor 4	1350	1187	900	247
Floor 9	1350	1145	900	973
Floor 14	1350	1125	900	846
Floor 15	1350	1148	900	970

AHU Supply Air Temperature

	DB	**WB**	**RH** (Relative Humidity)
Floor 4	55	52	80%
Floor 9	55	50	70%
Floor 14	55	48	60%
Floor 15	56	50	65%

Space Temperature

	DB	WB	RH
Floor 4	75	54	22%
Floor 9	75	57	31%
Floor 14	73	52	20%
Floor 15	75	50	10%

F. Results of Balance Report Analysis – Building No. 2

1. OA Supply

The measured OA supply to each floor is generally lower than the original building design. On average, OA quantity is 17% less than the original design. However, the actual OA supplied is in excess of the lease requirement and meets the code requirement applicable when the building was constructed. The amount of OA actually provided meets lease requirement and is acceptable.

2. Toilet Exhaust

The toilet exhaust quantity measured on most floors is per the original building design. Exception is 4^{th} floor where exhaust quantity is low.

3. AHU Supply Air Temperature

AHU supply temperature to each floor is 55ºF. This is the correct temperature for this system.

6. SURVEY RESULTS - BUILDING 3

A. Description of Building 3 HVAC System

Building 3 is a 15-story office building with approximately 550,000 SF area. The A/C system has two (2) chilled water Air Handling Units (AHU) on each floor. AHU's are located in separate rooms on each floor. Each AHU is a Variable Air Volume (VAV) type with fan inlet vanes for static pressure control.

Cold air is supplied through horizontal ducts to VAV terminal boxes. There are approximately 29 parallel fan powered VAV boxes with electric duct heaters which serve the perimeter zones. Zones served are approximately 450 square feet (SF) area. There are 18 shut off type boxes which serve interior zones. There are a total of 47 VAV boxes per floor. Average zone size is 595 SF. This small zone size normally provides excellent temperature control.

The ventilation system consists of two OA duct risers, one for each mechanical room. There is a central OA ventilation supply fan in the penthouse mechanical room which servers both risers. Air is supplied to each mechanical room to mix with return air and be circulated to the floor through the VAV boxes. Each floor is typically supplied 2,300 cubic feet per minute (cfm) of air.

B. Observations Building No. 3

As a result of our review, the following was noted for Building 3:

1. Building 3 construction started in April of 1990. Construction was completed in August 1991.

2. The building was designed per the 1990 BOCA code in effect at that time.

3. The GSA lease required a minimum ventilation rate of 5 cfm per person.

4. The 1990 BOCA mechanical code requires 20 cfm of “Ventilation” air per person. However, ventilation air is defined as total air circulation with “outside” air being 33% of the total. Or 33% of 20 = 6.6 cfm OA per person. The quantity of people is determined by the Building Code based on 100 square feet per person for the gross floor area. In Building 3, the gross floor area is 32,300 SF so the floor occupancy for calculating outside air requirements was 323 persons. This is 2,131 cfm of OA based on 6.6 cfm per person. The 6.6 cfm of OA exceeds the GSA lease requirement of 5 cfm per person.

5. The actual amount of OA supplied per floor per the original building design is 2,300 cfm. This exceeds the maximum code requirement by 8% and exceeds the GSA lease requirement by 42%.

6. The current applicable building code for office building ventilation is the 1996 International Mechanical Code (IMC). This code is based on ASHRAE standard 62-89. For this building the 96 IMC requires 20 cfm of OA per person. Occupant load is based on 7 persons per 1,000 SF of air conditioned

area. Occupant load per 96 IMC is therefore 28,000 SF A/C area ÷ 1,000 x 7 = 196 persons. OA requirement of 20 cfm per person is (196 x 20) = 3,920 cfm. The current code requires 70% more air than original design.

7. Air Balance Calculation

The following calculates the building exhaust rate compared to the supply air rate. This is to verify sufficient OA is supplied to balance building exhaust and to evaluate building pressurization. Building pressurization is the amount of OA supplied in excess of the exhaust rate. The total OA quantity supplied to the building is 33,640 cfm. This is supplied by the central OA supply fan. The total building exhaust is 21,525 cfm. This is based on the add up air quantity for toilet exhaust and janitors' closet exhaust for the building. Tenant drawings indicated that exhaust fans were provided for smoking rooms on each floor. However, these fans are not currently operated. The air balance calculation indicates an over supply of outside air of 12,115 cfm. This air quantity serves to "pressurize" the building. Each floor is typically supplied 2,300 cfm of OA. The toilet exhaust is 1,435 cfm. This yields a positive air balance of 865 cfm per floor to pressurize the floor.

C. <u>Conclusion - Building No. 3</u>

The quantity of OA provided for Building No. 3 exceeded the code requirement and lease requirement when the building was originally constructed. The existing OA quantity does not meet the building code now in effect.

D. Review of Existing HVAC System Design – Building No. 3

1. The existing system is of a "standard" design. However, it was considerably over designed in capacity due to lease requirement for additional electric equipment "plug" load added to the A/C calculation. A "plug" load of 7.5 watts per SF was required by the lease. The typical floor AHU capacity is 37,280 cfm. This includes 17,560 cfm for AHU A and 19,720 cfm for AHU B on typical floors 2 through 13. Floor air conditioned area is 28,000 SF. This provides 1.33 cfm per SF of air supply. Normal office buildings operate at 1.1 cfm/SF air supply. Because this is a VAV system, the system will operate satisfactorily at this lower air quantity.

2. A humidification system was installed for the building. This was done by adding an individual self-contained electric steam humidifier unit to each typical floor AHU. These humidifiers were operated for a short period. Operation was discontinued in early 1999.

3. A HVAC system “Block Load” calculation was made to check capacity of the typical floor AHU. The block load is based on typical floor actual load condition of 2 watts/SF for lights and 3 watts/SF for “plug load” power. This calculation indicates an AHU supply air quantity of 23,350 cfm is adequate for a typical floor. The actual AHU capacity for AHU A & B is 37,280 cfm. This is 47% higher than required.

The individual VAV boxes are also designed for this higher HVAC plug load than exists in the space. So box air quantity is higher than necessary.

4. Space Temperatures

All average space temperatures were in a good acceptable range for occupant comfort.

5. Individual VAV Box Air Quantity

Air quantity supply for most VAV boxes was measured to be close to design CFM indicated on tenant drawings. Some VAV boxes were low in air quantity. The low VAV box air quantity appears to be caused by control problems.

E. Analysis of Air Balance Report – Building No. 3

This is to summarize and discuss the air balance report findings for Building 3.

Existing OA Supply

	Design CFM	**Measured CFM**
Floor 2A	1100	1485
Floor 2B	1200	1287
Floor 8A	1100	1084
Floor 8B	1200	1165
Floor 15A	1150	1456
Floor 15B	1150	925

AHU Supply Air Temperature

	DB	WB	RH
Floor 2A	56	49	60%
Floor 2B	70	66	80%
Floor 8A	54	48	65%
Floor 8B	69	58	50%
Floor 15A	55	49	65%
Floor 15B	55	48	60%

Space Temperature

	DB	WB	RH
Floor 2A	74	56	30%
Floor 2B	75	58	34%
Floor 8A	74	62	50%
Floor 8B	74	65	60%
Floor 15A	74	60	44%
Floor 15B	75	57	31%

F. Results of Balance Report Analysis – Building No. 3

1. OA Supply

The measured OA supply to each floor is generally higher than the original building design. The actual OA supplied is in excess of the lease requirement and the code requirement applicable when the building was constructed. The amount of OA actually provided exceeds lease requirement and is acceptable.

2. AHU Supply Air Temperature

AHU supply temperature to each floor is typically 55ºF. This is the correct temperature for this system. Some floors were measured to have higher supply air temperatures. Floors served by AHUs with high supply temperatures tend to have high indoor humidity levels. High humidity levels can cause tenant discomfort, so should be avoided. AHU supply air temperature should be maintained at 55ºF to dehumidify the space in summer.

7. SURVEY RESULTS - BUILDING 4

A. Description of Building 4 HVAC System

Building 4 is a 13-story office building with approximately 278,000 SF area. The A/C system has two (2) chilled water Air Handling Units (AHU) on each floor. Units are located in a single mechanical room on each floor. Each AHU is a Variable Air Volume (VAV) type with fan inlet vanes for static pressure control. Cold air is supplied through horizontal ducts to VAV terminal boxes. There are approximately 24 parallel fan powered VAV boxes with electric duct heaters which serve the perimeter zones. Zone size is 450 (SF) area. There are 12 shut off type boxes which serve interior zones. There are a total of 36 VAV boxes per floor. Average zone size is 545 SF. This small zone size normally provides excellent temperature control.

The ventilation system consists of an OA duct riser with an intake louver in the penthouse wall. There is an OA ventilation supply fan on each floor in the mechanical room. This fan draws air out of the ventilation duct riser and supplies it to mix with return air and be circulated to the floor through the VAV boxes. The outside air fan is typically sized for 2,200 cubic feet per minute (cfm) of air.

B. Observations Building No. 4

As a result of our review, the following was noted for Building 4:

1. Building 4 construction started in October 1991. Construction was completed in April 1993.

2. The building was designed per the 1990 BOCA code in effect at that time.

3. The GSA lease required a minimum ventilation rate of 5 cfm per person.

4. The 1990 BOCA mechanical code requires 20 cfm of “Ventilation” air per person. However, ventilation air is defined as total air circulation with “outside” air being 33% of the total. Or 33% of 20 = 6.6 cfm OA per person. The quantity of people is determined by the Building Code based on 100 square feet per person for the gross floor area. In Building 4, the gross floor area is 23,000 SF so the floor

occupancy for calculating outside air requirements was 230 persons. This is 1,518 cfm of OA based on 6.6 cfm per person. The 6.6 cfm of OA exceeds the GSA lease requirement of 5 cfm per person.

5. The actual amount of OA supplied per floor per the original building design is 2,200 cfm. This exceeds the maximum code requirement by 45% and exceeds the GSA lease requirement by 90%.

6. The current applicable building code for office building ventilation is the 1996 International Mechanical Code (IMC). This code is based on ASHRAE standard 62-89. For this building the 96 IMC requires 20 cfm of OA per person. Occupant load is based on 7 persons per 1,000 SF of air conditioned area. Occupant load per 96 IMC is therefore 19,620 SF ÷ 1,000 x 7 = 138 persons. OA requirement of 20 cfm per person is (138 x 20) = 2,760 cfm. The current code requires 25% more air than original design.

7. Air Balance Calculation

The following calculates the building exhaust rate compared to the supply air rate. This is to verify sufficient OA is supplied to balance building exhaust and to evaluate building pressurization. Building pressurization is the amount of OA supplied in excess of the exhaust rate. The total OA quantity supplied to the building is 25,600 cfm. This is supplied by OA fans for each mechanical room. The total building exhaust is 19,800 cfm. This is based on the add up air quantity for toilet exhaust and janitors' closet exhaust for the building. Tenant drawings indicated that exhaust fans were provided for smoking rooms on each floor. However, these fans are not currently operated. The air balance calculation indicates an over supply of outside air of 5,800 cfm. This air quantity serves to "pressurize" the building. Each typical floor is supplied 2,200 cfm of OA. The toilet exhaust is 1,650 cfm. This yields a positive air balance of 550 cfm per floor to pressurize the floor.

C. Conclusion - Building No. 4

The quantity of OA provided for Building No. 4 exceeded the code requirement and lease requirement when the building was originally constructed. The existing OA quantity does not meet the building code now in effect.

D. Review of Existing HVAC System Design – Building No. 4

1. The existing system is of a "standard" design. However, it was considerably over designed in capacity due to lease requirement for additional electric equipment "plug" load added to the A/C calculation. A load of 7.5 watts per SF was required by the lease. The typical floor AHU capacity is

30,100 cfm. Floor air conditioned area is 19,620 SF. This provides 1.53 cfm per SF of air supply. Normal office buildings operate at 1.1 cfm/SF air supply. Because this is a VAV system, the system will operate satisfactorily at this lower air quantity.

2. A humidification system was installed for the building. This was done by adding an individual self-contained electric steam humidifier unit to each typical floor AHU. These humidifiers were operated for a short period. Operation was discontinued in early 1999.

3. A HVAC system "Block Load" calculation was made to check capacity of the typical floor AHU. The block load is based on typical floor actual load condition of 2 watts/SF for lights and 3 watts/SF for "plug load" power. This calculation indicates a total AHU supply air quantity of 18,676 cfm is adequate for a typical floor. The actual AHU capacity provided for AHU A & B is 30,100 cfm. This is 60% higher than required.

The individual VAV boxes are also designed for this higher HVAC plug load than exists in the space. So box air quantity is higher than necessary. As noted in the balance report, most of the VAV boxes are operating near the design air quantity.

4. Space Temperatures

All average space temperatures were in a good acceptable range for occupant control.

5. Individual VAV Box Air Quantity

Air quantity supply for most VAV boxes was measured to be close to design CFM indicated on tenant drawings. There were some VAV Boxes with low air quantity. The low VAV box air quantity appears to be caused by controls out of calibration or in operative controls.

E. Analysis of Air Balance Report – Building No. 4

This is to summarize and discuss the air balance report findings.

Existing OA Supply Fan

	Design	**Measured**

	CFM	CFM
Floor 3	2500	1877
Floor 7	2200	1750
Floor 13	1650	1284

AHU Supply Air Temperature

	DB	WB	RH
Floor 3A	60	54	70%
Floor 3B	60	58	90%
Floor 7A	57	52	70%
Floor 7B	56	52	78%
Floor 13A	58	54	80%
Floor 13B	58	52	68%

Space Temperature

	DB	WB	RH
Floor 3A	74	62	50%
Floor 3B	74	63	54%
Floor 7A	75	60	40%
Floor 7B	73	60	48%
Floor 13A	74	58	37%
Floor 13B	74	58	37%

F. Results of Balance Report Analysis – Building No. 4

1. OA Supply

The measured OA supply to each floor is generally lower than the original building design. However, the actual OA supplied is in excess of the lease requirement and meets the code requirement applicable when the building was constructed. The amount of OA actually provided meets lease requirement and is acceptable.

2. Floors 12 and 13.

These floors are not typical. They are smaller than the typical floor. Because they are smaller there is less outside air supplied. Original design was 1650 cfm of OA. Core toilets have the same design exhaust as typical floors which is also 1650 cfm. The actual OA quantity was measured to be 1284 cfm which is less than the exhaust. This would allow these two floors to be under “Negative” pressure. This situation has been corrected by increasing the OA flow to fans which serve these floors.

3. AHU Supply Air Temperature

AHU supply temperature to each floor is higher than 55ºF. This results in higher space humidity levels although they are still in an acceptable range. A 55ºF set point should be maintained.

8. FINDINGS AND RECOMMENDATIONS

The following is a summary if findings and recommendations as a result of our study of the buildings.

A. <u>Outside Air Ventilation</u>

1. *Finding:*

All Buildings have a positive supply of outside air. Outside air system capacity exceeds the lease requirement. OA system capacity meets the code in effect when buildings were constructed. The OA system does not meet the code now in effect or current National Ventilation Standards. Code standards have changed since the buildings were constructed. New codes require substantially more OA ventilation.

2. *Recommendation:*

Up-grade existing ventilation system to current code standards.

B. <u>Building Pressurization</u>

1. *Finding:*

The OA supply system capacity exceeds the exhaust system capacity so the buildings should have a positive pressure. This has been confirmed by review of the original design and by field measurements by the air balance contractor. The measured pressure is slightly positive in most buildings. It does not appear that building pressurization should contribute to moisture inflation. The exception is if the “morning warm up” control is allowed to operate during normal occupied hours. This control is used in cold winter months to heat each floor up to operating temperature from its colder night setback temperature. In morning warm up cycle, the OA supply is OFF and VAV Boxes operate on heat until the return air temperature rises to 68ºF. At that point the unit goes to occupied cycle and the OA damper opens. This control should only operate in the morning prior to start of normal occupied hours. If this control is allowed to operate during the day, the OA supply can stop for that floor.

2. *Recommendation:*

Limit use of morning warm up to before occupied hours. Program Energy Management System (EMS) to lockout morning warm up control so it will not operate during occupied hours.

C. <u>IAQ Observations of Air Handling Units, Humidifiers, Ductwork, Etc.</u>

1. *Findings:*

Observation of typical HVAC system components found no visible signs of conditions which would contribute to poor air quality.

· Air filters were of good efficiency, were clean and were of special construction to improve IAQ.

· AHU interiors were generally clean. AHUs in building 3 and 4 were easily accessible for cleaning and inspection. They had obviously been cleaned. AHUs in building 2 were not easily accessible for cleaning. Building Engineer reported they had been cleaned.

· AHU condensate drain pans in building 3 and 4 were observed to have water in them. Water was clean and anti-microbial chemical packs were in place. There was no observable mold.

· A humidifier discharge grid is installed in each AHU. These were observed in building 3 and 4 and appeared clean. Humidifiers are not now operated. Use of humidifiers is discouraged because they are typically not needed. Maintenance of winter humidity levels is normally only needed for areas with sensitive electronic environments. The energy code ASHRAE 90.1 states that humidifiers should be controlled to maintain a maximum indoor relative humidity of 30%.

2. *Recommendations:*

· Maintain current practice of routine cleaning of AHU interiors.

· Maintain current use of effective air filters.

· Continue routine cleaning and bacteria prevention treatment for AHU drain pans.

· Discontinue use of humidifiers to save energy.

· If humidifiers are used, set controls to maintain no higher than 30% RH in space. Set discharge high limit humidistat at 70% to prevent saturated air discharge from AHU.

D. Temperature Controls

1. *Findings:*

Several problems were noted with existing temperature controls. Pneumatic controls will go out of calibration as they age. Existing controls range in age from 8 to 11 years. Controls affect operation of VAV boxes and can reduce air flow.

2. *Recommendations:*

The following work is recommended to improve existing pneumatic temperature controls.

· Check all controls for proper operation. Repair or replace defective controls.

· Check and repair/replace all defective VAV Box controls.

· Check AHU discharge static pressure controls. Set to maintain 1.25 to 1.5 inches static pressure at point in supply duct system most remote from AHUs. This will make sure adequate pressure is available to maintain VAV Box air flow.

· Check AHU discharge temperature control. AHU discharge temperature must be maintained at no higher than 55ºF during spring, summer and fall seasons when cooling is needed. The 55ºF set point is necessary to dehumidify the space. This will keep space humidity low for comfort and to discourage mold growth. AHU discharge temperature may be set up to 60ºF in winter. This saves energy by reducing heat required.

· Check and set minimum VAV valve set points for all perimeter and interior VAV boxes. Original design drawings indicated a minimum valve set point of 20% air flow. Many boxes are not at this minimum. This minimum valve setting will provide space air volume turnovers for entire tenant space.

9. ANSWER TO QUESTIONS POSED IN LETTER FROM LARRY THOMAS DATED 3/29/00.

This is to answer questions posed in the letter from Larry Thomas NOAA Contracting Officer dated 3/29/00 regarding scope of services for this project. Our response to these questions is as follows:

1. Q). Is wall cavity part of return air path?

A) This item to be addressed by FEA and Dr. Jurinski.

2. Q) Operation of Typical floor AHU return air sensor in warm up mode.

A) Controls can allow AHU to return to warm up mode. Recommend this control be locked out during occupied hours.

3. Q) HVAC system source of contaminants.

A) Girard Engineering has spot checked AHU systems included in our scope of work. We have observed no possible source of contamination in these systems. Our consultant, Comfort Control has also observed AHU systems and has found no source of contamination.

4. Q) Check for unsanitary conditions.

A) None observed.

5. Q) Check fungi growth in ductwork.

A) None observed.

6. Q) Measure outside air quantity.

A) OA quantity has been measured on typical floors in each building. OA quantity exceeds lease requirements and complies with the code in effect when buildings were designed.

7. Q) Air intake damper size.

A) OA intake size is per original design and per code.

8a. Q) Measure ventilation rate.

A) Ventilation rate is per code.

8b. Q) Building pressure differential.

A) Buildings are positively pressurized.

9. Q) Measure air flow at VAV Boxes.

A) VAV Box air flow is generally lower than design in Building 2. The air flow is adequate because original design was greatly in excess of actual space load. In all buildings some VAV Boxes were observed to have bad controls which limited air flow. This condition should be corrected.

10. Q) Certify fire strops.

A) Not in Girard’s Scope of work.

11. Q) Certified balance report.

A) Not in Girard’s scope of work.

APPENDIX INDEX

5. Copy of applicable Ventilation Code.
6. Copy of Ventilation requirement from Lease.
7. HVAC load Calculations for Typical floors based on actual existing conditions. Includes:

   Building 2

   Building 3 AHU A & B

   Building 4 AHU A & B
8. Comfort Control Air Balance Report Data.